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Entrepreneurial activities in Smart Cities: Evidence from Portugal

PEDRO MIGUEL LOPES MOTA VEIGA
UNIVERSIDADE DA BEIRA INTERIOR (UBI)

JOÃO JOSÉ DE MATOS FERREIRA
UNIVERSIDADE DA BEIRA INTERIOR

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1. INTRODUCTION

Currently, in the context of globalization and interdependence of national economies, the exclusive use of traditional national policies promoting development, seems to be insufficient to address the issues alluding to that same development. The management of cities thus faces the challenge of making living conditions more attractive so that they become more appealing to people's permanent lives. Indeed, a significant part of the responsibility for development has in many cases shifted from the national to the regional and local level, with local governments taking a leading role in the process by seeking and driving innovative, smart, and sustainable solutions (Ascani et al., 2012; Kraus et al., 2015; Kummitha, 2019). One of the development instruments and policies particularly widespread in the last decades in the hands of local authorities is the choice to transform cities into smart cities (SC) (Ascani et al., 2012).

SC has mainly emerged as a result of highly innovative information and communication technology (ICT) industries and markets and have started to use new solutions leveraging technologies related to digital transformation. Due to this fact, SC adopts a networked infrastructure not only for the social, cultural, and urban development of cities but also because it opens new market opportunities for entrepreneurs to exploit (Kummitha, 2019; Penco et al., 2021). A key feature of a SC is to take initiatives to promote and strengthen new innovative ideas that serve specific economic sectors or groups of entrepreneurs (Ferraris et al., 2020; Manjon et al., 2022). The main concern should be to create conditions and a culture that drives entrepreneurship, based on innovation, to achieve the desired growth and make the city attractive to new resources and investments (Crecente et al., 2021; Kummitha, 2019; Schiavone et al., 2020)

Although the introduction of various elements of the SC concept is relatively common in many countries around the world, including European ones, most research on entrepreneurship has focused on entrepreneurial activities in large urban areas (Scornavacca et al., 2020). Similarly, despite the existence of studies that have found SC to be more entrepreneurial there is still a need to better understand the entrepreneurship-related aspects of SC (Scornavacca et al., 2020)In particular, there are gaps in terms of empirical testing of the conceptual frameworks developed in research on SC and entrepreneurial activity (Zhao et al., 2021). particularly what intelligent characteristics are responsible for the greater entrepreneurial activity in the KS (Barba-Sánchez et al., 2019; Cruz & Silva, 2021; Kummitha, 2019; Manjon et al., 2022; McGuirk et al., 2021; Richter et al., 2015; Santos, 2022).

To fill this gap this research aims to identify which attributes are particularly relevant in fostering entrepreneurship in a SC, it intends to answer the following research question:

What are the main factors in the KS that encourage entrepreneurial activity?

The aim was to answer the research question within the context of Portuguese municipalities by using a set of data collected from two secondary data sources, INE and PORDATA. The data collected consists of a set of various indicators identified as SC indicators for the 278 continental municipalities in Portugal. We test our hypotheses using structural equation models. This dataset allowed us to test the theoretical assumptions, as well as to gain further insights into the SC indicators that promote entrepreneurial activity. We found support for our theoretical arguments suggesting that Smart People, Smart Living and Smart Environment factors have a significant impact on Entrepreneurial Activity. Specifically, we observed that Smart People is the dimension that has the greatest impact on entrepreneurial activity.

This study makes three main contributions. First, this study contributes to recent work on entrepreneurial ecosystem development associated with SC. Previous studies have focused solely on

the interactions between SC and entrepreneurship, mainly based on case studies (e.g. Kirimtat et al., 2020; Scornavacca et al., 2020; Zhao et al., 2021)case studies, research on large cities or medium cities (e.g. Crecente et al., 2021; Kóňa et al., 2022; Leroux & Pupion, 2022)while this study discusses the path for the development of the entrepreneurial activity of municipalities and cities based on knowledge and quality of life-based on data for all municipalities in mainland Portugal. This study also includes spatial elements with potential impact on the interconnection between the various components of KS, few studies include this component (e.g. Kraus et al., 2015; Zhao et al., 2021). The determination of the spatial location of the business is one of the most complex long-term decisions for the establishment of new businesses. (Bilen et al., 2019)This study aims to assist entrepreneurs in the decision process of choosing the location effectively based on the set of smart specific resources Fand ideal places for the establishment of their business.

2. LITERATURE REVIEW

2.1. Smart Cities

The roots of the SC concept date back to the 1960s, incorporated into urban development plans and termed cybernetically planned cities (Gabrys, 2014). However, although research on SC can be traced back to the 1990s (Gibson et al., 1992)the last decade has witnessed an exponential growth in research and expansion into diverse scientific domains, taking on multiple perspectives (Kummitha, 2019). A search on the Web of Science reveals that the number of scientific publications has increased twenty-fold in the last decade and they are published in areas as diverse as Urban Studies, Environmental Sciences, Economics and Business, Operations Research and Decision Science, Mathematics, Public Administration, Information Science, Control and Automation Systems and Architecture.

Given this multidisciplinary diversity of the KS, each domain adopts its language, defining actions to pursue specific objectives and no definition includes all aspects of the KS (Cruz & Silva, 2021; Russo, Rindone, Panuccio, et al., 2014). In general, definitions can be classified as referring to inputs, activities, and outputs for the implementation of a smart city; objectives for achieving the implementation of SC solutions (Kirimtat et al., 2020; Zhao et al., 2021). As regards the research conducted, this essentially addresses four areas: the technological aspect, including the technological infrastructure and support network for the construction of smart cities, the socio-cultural aspect, such as citizen engagement, the political-institutional aspect, namely governmental support and policies, and the economic-business aspect, namely business models and profitability of companies operating in that technological sector. (Bibri & Krogstie, 2017; Cruz & Silva, 2021; Kummitha & Crutzen, 2017; Zhao et al., 2021).

The concept of SC is becoming more and more widespread, and many cities try to achieve the highest possible level of intelligence through different smart city initiatives. Hollands (2008), in his seminal work on SC, argues that cities and governments often tend to just claim that they are smart without providing real evidence to support such an announcement or even defining its precise meaning. As academic interest in SC began to grow researchers began to explore a variety of dimensions and practicalities related to its operation (Kummitha & Crutzen, 2017). With this evolution, the concept of SC evolves from an orientation toward the diffusion of digital technology and in the economic and corporate potential of SC projects to a second generation where the approach is more decentralized and anthropocentric and in ways to promote collaboration and community involvement (Kummitha & Crutzen, 2017; Zhao et al., 2021).

Currently, SC management has been seen as a strategy to address the challenges facing city governments such as rapid urbanization and significant demographic changes (Bibri & Krogstie, 2017; Franco & Rodrigues, 2022; Vaz et al., 2022; Zhao et al., 2021), climate and environmental

change (Bibri & Krogstie, 2017; Lebiedzik, 2020; Mitra et al., 2022), economic restructuring and reforms (Manjon et al., 2022; Navío-Marco et al., 2020; Soeiro, 2020) and digital technology disruptions (Barba-Sánchez et al., 2019; Mitra et al., 2022; Zhao et al., 2021). Several key components that constitute a smart city and various emphases have been reported in the literature (Kirimtat et al., 2020; Kóňa et al., 2022; Soeiro, 2020). However most current definitions are based on a model composed of six distinct dimensions: smart mobility, Smart Environment, Smart Living, Smart People, smart economy, and Smart Governance (Bibri & Krogstie, 2017; Franco & Rodrigues, 2022; Kummitha & Crutzen, 2017; Leroux & Pupion, 2022; Zhao et al., 2021). This conceptualization represents a holistic vision for SC, concerning the complementarity of these dimensions (Bibri & Krogstie, 2017).

Since 2012 the European Union (EU) is investing in research and innovation and developing policies on SC to achieve a triple financial gain for Europe: better quality of life for citizens, more competitive industry and SMEs, and more sustainable energy, transport, and ICT systems and infrastructure (Russo, Rindone, & Panuccio, 2014). For the development of these policies, the EU has established a set of partnerships with various actors in the focus areas of energy, transport, and information and communication technologies and has the main purpose to accelerate progress in these areas and offer new interdisciplinary opportunities to improve services while reducing energy and resources consumption. (Orejon-Sanchez et al., 2022). The EU Urban Agenda also recognizes Europe's diverse structure and emphasizes the need for cities to cooperate within their functional areas and with their surrounding regions. (Medeiros & Rauhut, 2020; Navío-Marco et al., 2020). Medium-sized towns are thus seen as anchors of territorial cohesion, linking and reinforcing territorial and urban policies to maximize their added value for other communities in the surrounding rural and peripheral areas (Medeiros & Rauhut, 2020; Navío-Marco et al., 2020)Therefore, SC initiatives are not only limited to urban areas but also wider and narrower geographical areas (Schaffers et al., 2012). Currently, the management of municipalities faces the challenge, framed within the SC concept, of making living conditions in municipalities and towns more appealing so that they become more attractive for the permanent living of people, (Lebiedzik, 2020).

2.2. Smart Cities and Entrepreneurship

Entrepreneurship has become a priority strategy for promoting urban and regional competitiveness (Fernandes et al., 2021; Veiga et al., 2017, 2020). The most successful territories are those that are characterized by the capacity, on the part of firms and institutions, to adopt learning dynamics, and respond better to pressures induced by market dynamics (Santos, 2019). Technology is a necessary condition for a KS, but it is not sufficient, as the development of the urban fabric towards a more qualified and resilient economy must also address the entrepreneurial propensity in that context (Santos, 2017). In the dynamic and challenging innovation entrepreneurial ecosystems of SC, entrepreneurs have to play an even more important role than usual in terms of identifying and exploiting opportunities (Kraus et al., 2015). The research conducted suggests that SC is of particular interest to entrepreneurs because they offer a broad scope of innovation sources and business opportunities (Cruz & Silva, 2021; Zhao et al., 2021). From an entrepreneurship perspective, a SC is defined as an urban entrepreneurial and innovation ecosystem (Camboim et al., 2019; Kóňa et al., 2022; Mitra et al., 2022; Santos, 2017, 2019)where creativity and innovation, combined with digital infrastructure, foster entrepreneurship (Fernandes et al., 2022; Kraus et al., 2015; Vaz et al., 2022).

Research approaches largely revolve around the interactions between SC and entrepreneurship (Zhao et al., 2021). Santinha *et al.* (2019) present a case study, based on the city of Águeda, located in the NUTS II Central Region of Portugal, that illustrates how the local structures of a medium-

sized city in Portugal apply the SC concept in that context and how it has generated value for the city. Although the channels of communication and collaboration between local higher education institutions and the remaining stakeholders have increased in recent years Santinha *et al.* (2019) recognize that several obstacles to the exploitation of business opportunities persist, namely the resistance of the local industrial and commercial fabric to cooperate and participate in networks. Santos (2019) analyzed how critical entrepreneurship issues are for KS or the challenging reconfiguration that urban policies have to face in promoting KS competitiveness. To this end, Santos (2019) evaluated the entrepreneurial ecosystem of Coimbra (Portugal) in terms of its emergence, innovative profile, governance, and key success factors, concluding that the Smart Coimbra project[i] has brought great benefits, particularly its contribution to restoring the city's prestige in terms of entrepreneurial dynamics. Bernardino *et al.* (2020) Evaluated the extent to which it is possible to make SC more humanized and sustainable through social entrepreneurship. Bernardino *et al.* (2020) analyzed social entrepreneurship initiatives operating in the two main Portuguese cities, Lisbon and Porto, concluding that through social entrepreneurship initiatives it is possible to increase the improvement in the quality of life of its citizens and the sustainable resolution of some of the most urgent social imbalances, contributing positively to greater value creation in cities. McGuirk *et al.* (2021) evaluated theorizations on the evolution of urban governance through the lens of urban entrepreneurship to examine how the roles and practices of the city government are being reshaped and reoriented. McGuirk *et al.* (2021) conducted empirical research on SC governance in Australia's two largest cities, Sydney and Melbourne, and identified the active roles and constitutive and experiential practices of entrepreneurial municipal governance involved in SC governance. Manjon *et al.* (2022) researched the relationship between the implementation of SC initiatives and the number of start-ups, particularly those related to green entrepreneurship and digital entrepreneurship. In a sample of Belgian municipalities, Manjon *et al.* (2022) conclude the existence of a positive relationship between SC initiatives and entrepreneurship rates, however having smart city initiatives with sustainable and/or digital orientations generally has no impact on entrepreneurship rates, with the exception of digital rates in large municipalities. Mitra *et al.* (2022) propose a framework for the development of a SC startups ecosystem, concluding, based on four SC startups, that digital infrastructure facilitates new forms of entrepreneurship and that a startups ecosystem in this framework lacks special provisions that include the development of a knowledge hub. This suggests the following hypothesis about the relationship between SC initiatives and entrepreneurial activity.

Hypothesis 1: Smart Governance has an impact on entrepreneurial activity
Hypothesis 2: Smart Environment has an impact on entrepreneurial activity.
Parameter 3: Smart Living has an impact on entrepreneurial activity
Hypothesis 4: Smart People have an impact on entrepreneurial activity

The years of austerity experienced in the European Union, stemming from the 2008 financial crisis, meant that previously flourishing regions suffered serious economic declines, while capital cities and large metropolitan areas were largely protected from this economic situation (Parkinson et al., 2015)...notably because foreign direct investments have been mainly allocated to cities and conurbations (Medeiros & Rauhut, 2020). The high availability of infrastructure, including transport, business services, housing, and a range of public services, is one of the main economic driving forces in cities and urban regions, producing numerous social and spatial effects (Hollands, 2008). For peripheral regions, place-centered approaches mean that local actors take greater responsibility for the economic and social agenda (Medeiros & Rauhut, 2020; Orejon-Sanchez et al., 2022). Kóňa *et al.* (2022) assessed the relationship between the distribution in the territory of the Slovak Smart City Index and the size of municipalities, as well as the number of funds

implemented from the European Structural Funds Kóňa *et al.* (2022) They determined a clear difference between smaller municipalities, which are significantly boosted by the proximity of a larger city and jump to higher positions in the overall ranking than large municipalities in areas where there are no larger cities. This leads us to formulate the following hypothesis related to the main Portuguese metropolitan areas:

Hypothesis 5: The impact of Smart Governance on entrepreneurial activity is moderated by a) distance to Lisbon, b) distance to Oporto

Hypothesis 6: The impact of the Smart Environment on entrepreneurial activity is moderated by a) distance to Lisbon, b) distance to Oporto

Hypothesis 7: The impact of Smart Living on entrepreneurial activity is moderated by a) distance to Lisbon, b) distance to Oporto

Hypothesis 8: The impact of Smart People on entrepreneurial activity is moderated by a) distance to Lisbon, b) distance to Oporto

Figure 1 presents the conceptual basis of analysis to answer the research hypotheses defined in the study.

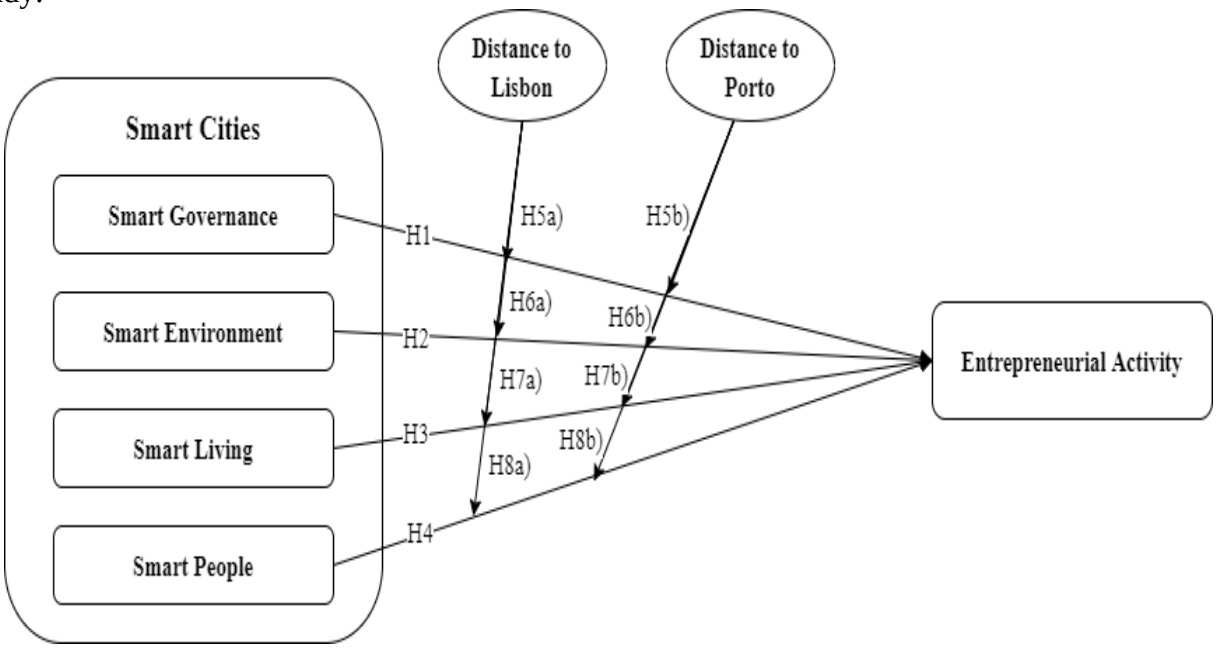

Figure 1: Research Model.

3. RESEARCH METHODOLOGY

3.1. Sample and data

The data collected focused on the 278 continental municipalities of Portugal (unit of analysis). Data collection was based on several secondary sources, namely the National Statistics Institute (INE) and PORDATA. Most of the indicators used referred to the year 2020, except for some variables that only existed for the years 2019 and 2021 (the year of the General Population Census). Table 1 shows the variables associated with each construct.

Table 1: Variables included in the study

	Variable/construct	Unit
GI	**Smart Governance**	
GI1	Budgetary balance	% of revenue
GI2	Expenditure of Municipal Councils on culture and sport per resident	euros
GI3	Abstention rate in the elections for Local Authorities	% of voters
GI4	Abstention rate in the elections for the Assembly of the Republic	% of voters

GI5	Municipal Transparency Index	Number Index
AI	**Smart Environment**	
AI1	Quality compliance analyses	%
AI2	Municipal waste collected per inhabitant	kg
AI3	Urban waste is selectively collected per inhabitant	kg
AI4	Environmental management and protection	% of expenditure
AI5	Waste management	% of expenditure
AI6	Analyses carried out	%
VI	**Smart Living**	
VI1	Inhabitants per firefighter	Number
VI2	Purchasing power	Number Index
VI3	Pedestrians run over per 1,000 inhabitants	Number
VI4	Synthetic Fertility Index	Number Index
VI5	Foreign population with legal resident status	% of resident population
VI6	Fatalities per 100 road accidents with victims	Number
VI7	Unemployment benefit recipients	% of active beneficiaries
IP	**Smart People**	
PI1	Amounts are withdrawn per inhabitant from ATMs	euros
PI2	Amounts of payments at ATMs per inhabitant	euros
PI3	Retention and dropout rates in basic education	% Students Enrolled
PI4	Retention and dropout rates in secondary education	% Students Enrolled
PI5	The average value of purchases made at automatic payment terminals	euros
EMP	**Entrepreneurial Activity**	
EMP1	The birth rate of companies	% of total companies
EMP2	The one-year survival rate of non-financial companies	% of companies created
EMP3	Employers	% of total employees
EMP4	Gross value added per capita	thousands of euros
EMP5	Average monthly earnings of employees	euros

3.2. Statistical methods

To validate the hypotheses under study, a structural equation model (SEM) was used, with the partial least squares method (*Partial Least Squares* - PLS) being used as an estimation method, a method currently quite widespread in the area of behavioral sciences (Hair et al., 2020). The use of PLS-SEM as an alternative to covariance-based SEM (CB-SEM) was due to items not following normal distribution and being measured in distinct units, two assumptions of the characteristics of the data to be used CB-SEM (Freeman & Styles, 2014; Hair et al., 2019, 2020; Sarstedt et al., 2019).

To confirm the factor structure of the instrument used it was necessary to examine the reliability and validity of the indicators used in representing and measuring the theoretical concepts (Hair et al., 2019, 2020; Sarstedt et al., 2019). Construct validity is the magnitude by which a set of items reflects the latent theoretical construct they intend to measure and the reliability of an instrument refers to the property of consistency and reproducibility of the measurement (Hair et al., 2019, 2020; Sarstedt et al., 2019).

Construct validity was assessed through (1) composite reliability (CR), (CR > 0.70); (2) individual reliability (factor loadings greater than 0.5 ideally greater than 0.707); (3) convergent validity, through the Average Variance Extracted (AVE), convergent validity was assumed to exist when (AVE > 0.50); and (4) discriminant validity, where the square root of the AVE of two constructs should be greater than the correlation between these two factors (Barroso et al., 2010; Fornell & Larcker, 1981; Hair et al., 2010; Henseler et al., 2015; Sarstedt et al., 2019). Table 2 presents a summary of the criteria for the analysis of the validity and reliability of the data collection instrument used.

Table 2: Indicators of instrument validity

Statistics	**Reference values**

Individual reliability	≥ 0.5, ideally ≥ 0.707
Composite Reliability	$CR \geq 0.7$
Convergent validity	$AVE_j \geq 0.5$
Discriminant validity	$AVE_j \geq R^2$

With a view to the overall evaluation of the structural model, we examined the overall fit of the estimated model, the path coefficient estimates and their statistical significance based on *bootstrap*, and the coefficient of determination (R^2) (Hair et al., 2019, 2020; Sarstedt et al., 2019). In the estimation of structural models, to determine the *t-statistics* and respective statistical significance, we applied the *bootstrapping* procedure (with a sample of 10,000 *bootstraps*). All calculations were performed using the SmartPLS *software* version 4.0.7.4 (Ringle et al., 2015) and IBM SPSS version 28.0 for Windows (IBM Corporation, New York, USA).
The estimates of the structural model were used to determine the scores of the factors Smart Governance, Smart Environment, Smart Living, Smart People, and Entrepreneurial Activity. The average of these scores, corresponding to the national average, was based on 100.

4. RESULTS

4.1. Validity and reliability of the constructs

Table 3 shows the results concerning the descriptive statistics, reliability, and validity of the latent constructs. For all constructs, factor loadings and composite reliability are above the required limits of 0.5 and 0.7, respectively, and AVE is above the limit of 0.5. To test whether the constructs were sufficiently different from each other, discriminant validity was inspected using the Fornell and Larcker (1981) criterion, which requires that the AVE of a construct be greater than the square of its highest correlation with any construct (Table 4). It is observed that the various constructs have high levels of reliability, as well as factor validity, convergent validity, and discriminant validity, and can be considered valid and reliable to be used.

Table 3: Validity and reliability of the constructs

Construct/Indicator	Average	Standard Deviation	Factor loadings	CR	AVE
GI	**100,0**	**3039,1**		**0,823**	**0,511**
GI1	3,5	11,1	0,748		
GI2	11,1	5,4	0,538		
GI3	19,7	29,7	0,852		
GI4	47,3	5,8	-0,686		
GI5	50,9	16,9	0,713		
AI				**0,789**	**0,689**
AI1	100,0	45,0	-0,984		
AI2	192,9	625,6	0,987		
AI3	39,5	5,6	0,562		
AI4	71,4	206,0	0,684		
AI5	11,8	2,0	0,676		
AI6	1,3	1,9	-0,975		
VI	**100,0**	**44,5**		**0,712**	**0,583**
VI1	327,7	262,1	-0,629		
VI2	81,3	17,8	0,878		
VI3	4,0	1,0	-0,893		
VI4	1,2	0,3	0,614		
VI5	0,0	1,0	0,511		

VI6	2,8	3,9	-0,816		
VI7	3,9	1,3	0,752		
IP	**100,0**	**45,1**		**0,849**	**0,539**
PI1	192,9	625,6	0,913		
PI2	39,5	5,6	0,539		
PI3	71,0	206,0	0,569		
PI4	11,8	2,0	0,645		
PI5	1,3	1,9	0,913		
EMP	**100,0**	**30,0**		**0,798**	**0,505**
EMP1	13,1	3,2	0,890		
EMP2	75,5	4,7	0,723		
EMP3	0,1	0,0	0,664		
EMP4	5996,2	4186,1	0,642		
EMP5	750,3	216,0	0,597		

Table 4: Correlation between constructs (square root of AVE on the diagonal)

	GI	AI	CV	IP	EMP
GI	0,715				
AI	0,348	0,830			
CV	0,370	0,311	0,763		
IP	0,322	0,309	0,650	0,734	
EMP	0,327	0,233	0,380	0,432	0,711

4.2. Hypothesis testing

Table 5 and Figure 2 present the results alluding to the structural model to validate the hypotheses. The estimated structural model presents a good predictive power (R^2 = 88.8%).

About Hypothesis 1: Smart Governance impacts entrepreneurial activity, it is found that Smart Governance has no statistically significant impact on entrepreneurial activity ($\beta = 0.14$; $p = 0.114$), and it is not possible to support this hypothesis.

Regarding Hypothesis 2: Smart Environment impacts entrepreneurial activity, it is observed that Smart Environment positively influences entrepreneurial activity ($\beta = 0.32$; $p < 0.05$), supporting the hypothesis.

Regarding Hypothesis 3: Smart Living impacts entrepreneurial activity, it is found that there is a statistically significant positive Smart Living impact on entrepreneurial activity ($\beta = 0.34$; $p < 0.01$), supporting this hypothesis.

In terms of Hypothesis 4: Smart People have an impact on entrepreneurial activity, it is observed that there is a positive impact with statistical significance of Smart People on entrepreneurial activity ($\beta = 0.44$; $p < 0.01$), also supporting this hypothesis.

Finally, in terms of the moderating effects of distance to Lisbon and Oporto (H5 to H8), we observe the existence of statistically significant moderating effects of distance to Lisbon ($\beta = 0.23$; $p < 0.05$) and distance to Oporto ($\beta = 0.20$; $p < 0.05$) on the relationship between Smart Governance and entrepreneurial activity. The greater the distance between Lisbon and Porto the greater the impact of Smart Governance and entrepreneurial activity, being the lower this impact in the municipalities closer to these metropolitan areas. These results allowed supporting hypotheses H5a) and H5b).

Table 5: Standardised coefficients of the estimated model

		Beta	**EP**	**t**	**p**
H1	Smart Governance	0,14	0,17	1,58	0,114
H2	**Smart Environment**	**0,32**	**0,16**	**2,01**	**0,044***
H3	**Smart Living**	**0,34**	**0,16**	**2,07**	**0,038***

H4	**Smart People**	**0,44**	**0,09**	**4,99**	**0,000****
H5a)	**Distance to Lisbon x Smart Governance**	**0,23**	**0,11**	**2,09**	**0,038***
H6a)	Distance to Lisbon x Smart Environment	0,09	0,07	1,29	0,200
H7a)	Distance to Lisbon x Smart Living	0,08	0,08	1,05	0,295
H8a)	Distance to Lisbon x Smart People	0,06	0,06	1,02	0,311
H5b)	**Distance to Porto x Smart Governance**	**0,20**	**0,10**	**2,07**	**0,040***
H6b)	Distance to Porto x Smart Environment	0,05	0,07	0,73	0,467
H7b)	Distance to Porto x Smart Living	0,05	0,06	0,82	0,413
H8b)	Distance to Porto x Smart People	0,09	0,06	1,43	0,155

NOTE: SE - Standard Error; * p < 0,01; ** p < 0,01

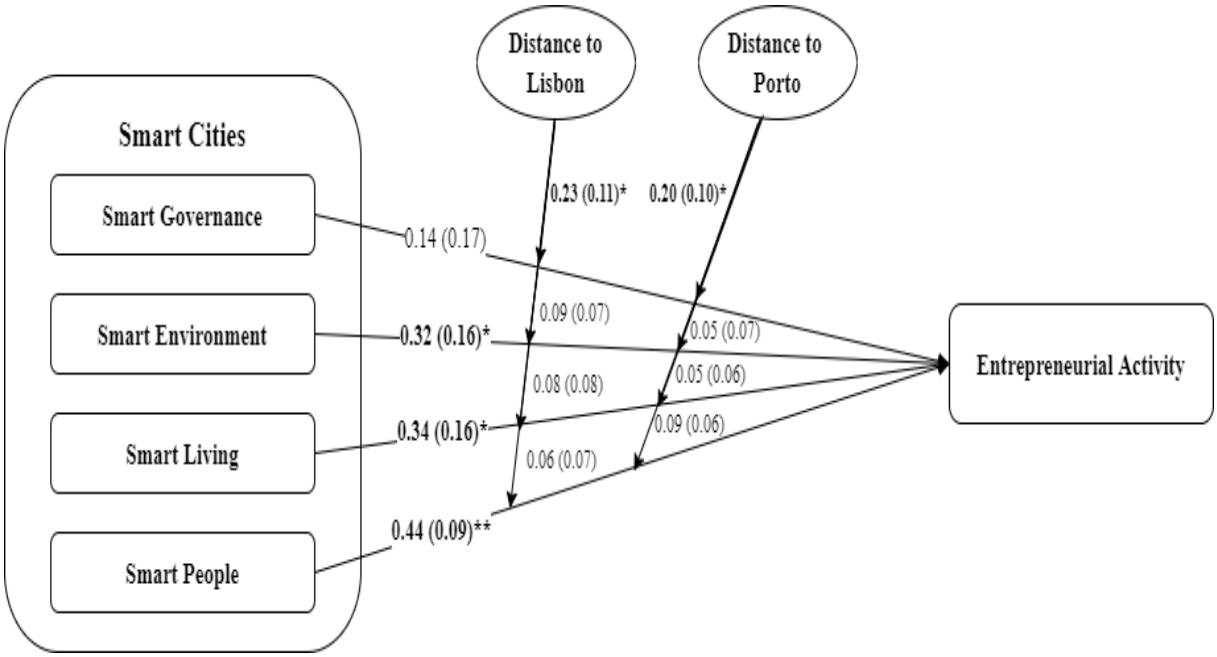

Figure 2: Estimated Research Model (Beta and Standard Error)

4.3. Spatial distribution

This section presents the spatial distribution for each of the SC dimensions analyzed (Figure 3), as well as the entrepreneurial activity (Figure 4). Regarding Smart Governance, the highest levels are mainly observed in the Lisbon Metropolitan Area and the North Coast, with the municipalities with the highest scores being Sintra, Vizela, Vila Nova de Famalicão, Braga, and Oliveira de Azeméis. As for Smart Environment, the municipalities with higher scores are relatively dispersed throughout the country, with the highest scores being observed in the municipalities of Ovar, Sesimbra, Cascais, Alpiarça, and Viseu. In terms of the Smart Living scores, although there is also some geographical dispersion of the municipalities with higher levels of quality of life, the municipalities in the Algarve stand out in general, with the municipalities of Lisbon, Albufeira, Faro, Loulé, and Porto presenting the highest scores. The municipalities with higher scores in the Smart People dimension are also relatively dispersed throughout the country, with higher average scores in the municipalities of Lisbon, Sines, Oeiras, Porto, and Alcochete.

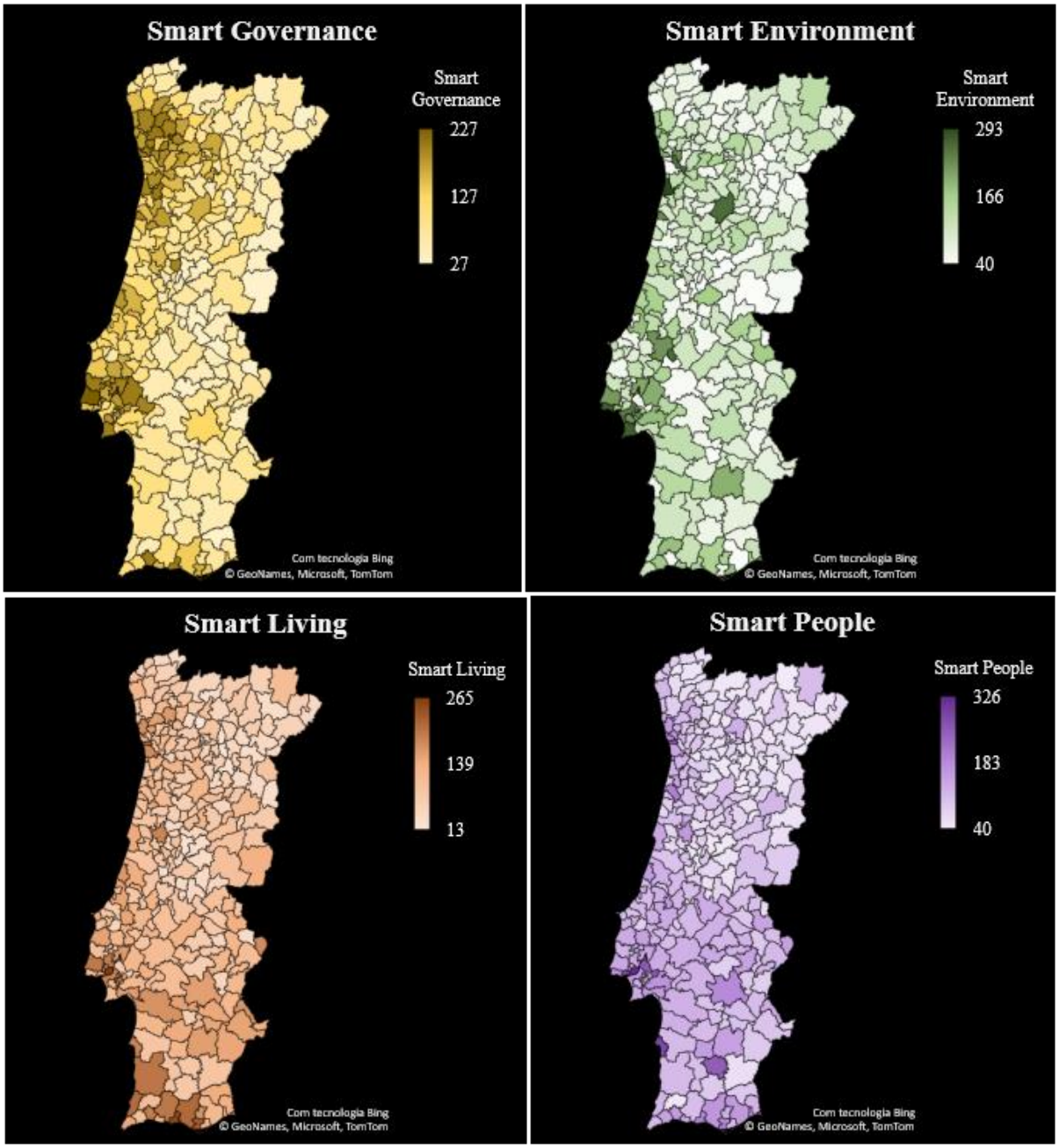

Figure 3: Spatial distribution of the four dimensions of Smart Cities

Finally, the spatial distribution of Entrepreneurial Activity is presented, observing that the North Interior presents the lowest levels of entrepreneurial activity. The municipalities of Vila Velha de Ródão, Castanheira de Pera, Oliveira de Frades, Lisbon and Oeiras are those that present the highest levels of entrepreneurial activity.

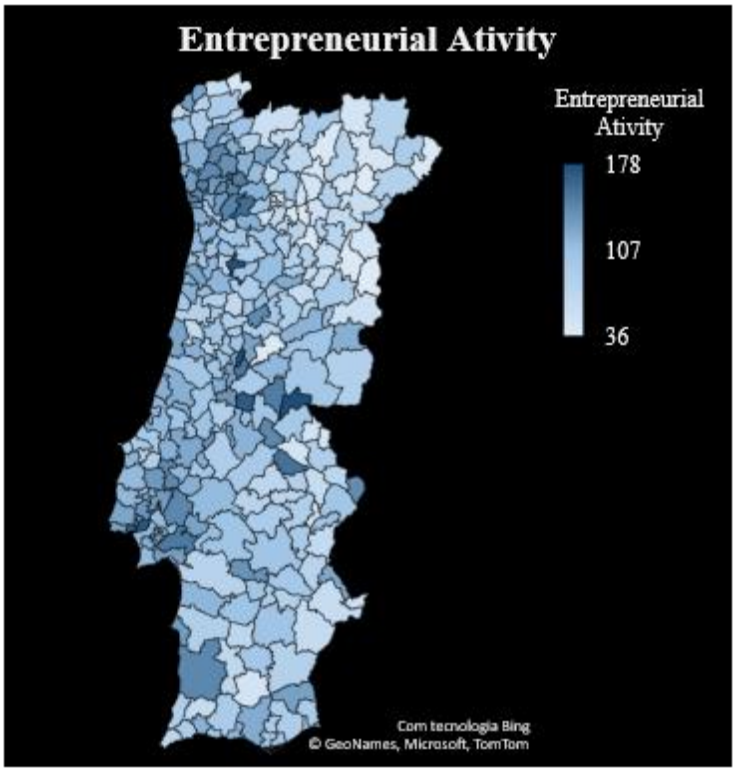

Figure 4: Spatial distribution of entrepreneurial activity

5. DISCUSSION

SC is an opportunity to trigger innovation and entrepreneurship for urban development. In our study, we intend to identify the impact of Smart Governance, Smart Mobility, Smart Environment, Smart Living (quality of life), and Smart People on entrepreneurial activity and how the distance to the main Portuguese metropolitan areas (Lisbon and Porto) moderates these impacts.

Based on the data it was found that Smart Governance has no statistically significant impact on entrepreneurial activity (Hypothesis 1). Although our results do not reveal smart cities thus result in the creation of new business locations, this is reflected in the fact that there is generally a higher degree of entrepreneurship in SC compared to other cities (Barba-Sánchez et al., 2019; Bibri & Krogstie, 2017; Kóňa et al., 2022; Kummitha & Crutzen, 2017; Rodrigues & Franco, 2018; Zhao et al., 2021). The dynamic interactions between the urban and business ecosystems produce a virtuous circle (Mitra et al., 2022; Santos, 2022). The success of the government in SC depends on the provision of services by the municipality, however, these should not only be progressive in pursuing technological developments but should also have smart management and government policies that enable citizens to train better quality of life (Kóňa et al., 2022; Lebiedzik, 2020; Rodrigues & Franco, 2018; Zhao et al., 2021).

Based on the sample under study it was possible to support Hypothesis 2, Smart Environment positively influences entrepreneurial activity. Smart Environment is one of the most relevant characteristics in the scope of SC (Kirimtat et al., 2020; Kóňa et al., 2022; Kraus et al., 2015; Zhao et al., 2021). Characteristics such as domestic water quality, emissions monitoring, waste management, and energy efficiency are significant features of sustainable SC. This directly affects the quality of life of people living in urban areas, but also the propensity for new business creation (Bibri & Krogstie, 2017; Kóňa et al., 2022; Leroux & Pupion, 2022; Ulitskaya et al., 2021; Zhao et al., 2021).

Hypothesis H3 was also supported by the data, observing that Smart Living has an impact on entrepreneurial activity. One of the main concerns in Smart Living is public safety, as it affects the

quality of life of households as well as economic activity (Kirimtat et al., 2020; Kóňa et al., 2022). Increasing quality of life is one of the main objectives of SC, since people are the users of smart devices and services, and it is very important to plan and design these services properly for an increase in entrepreneurial activity (Kirimtat et al., 2020; Kóňa et al., 2022; Zhao et al., 2021). Our Hypothesis 4 was also supported since the existence of a positive impact with statistical significance of Smart People on entrepreneurial activity was observed. Smart People want to live in cozy and smart places; therefore, urban design is a key asset (Camboim et al., 2019; Vahtera et al., 2017). This dimension reinforces the importance of human capital in promoting entrepreneurship (Barba-Sánchez et al., 2019; Bibri & Krogstie, 2017; Kirimtat et al., 2020; Kóňa et al., 2022).

As for the moderating effect of the distance between Lisbon and Porto on the relationship between SC dimensions and entrepreneurial activity, it was observed that the greater the distance between Lisbon and Porto the greater the impact of Smart Governance and entrepreneurial activity, while this impact is lower in the municipalities closer to these metropolitan areas. These results reveal that although capital cities and large metropolitan areas are in general protected from economic recessions (Parkinson et al., 2015)...local policies have less impact on entrepreneurial activity than in more peripheral municipalities where place-based approaches mean that local actors take greater responsibility for the economic and social agenda (Medeiros & Rauhut, 2020; Orejon-Sanchez et al., 2022).

Implications

This research contributes to the discussion on the development of entrepreneurial ecosystems associated with SC. The study proposes a framework consisting of four pillars (Smart Governance, Smart Environment, Smart Living, and Smart People) with an effect on Entrepreneurial Activity. The study also discusses possible pathways for the development of the knowledge-based city economy with implications for collaborative decisions for the development of entrepreneurial and innovation ecosystems by policymakers, city executives, entrepreneurs, investors, and other stakeholders. Furthermore, the determination of the spatial location of the business is one of the most complex long-term decisions for the establishment of new businesses, with this study we intended to create rankings for the characteristics 278 of the smart municipalities of mainland Portugal as a form of aid in the decision process of choosing the location effectively and help entrepreneurs to determine which set of these specific smart features ideal locations for the establishment of their business. Finally, this study also intended to contribute with spatial elements with potential impact on the interconnection between the various components of the SC, particularly the distances to the two major Portuguese metropolitan areas, Lisbon and Porto.

Limitations and future lines of research

This study is not exempt from limitations. One of them is the subjectivity in the selection of indicators, dependent on the availability of reliable statistics in the geographical unit analyzed, the municipality. Another limitation is that the empirical analysis is carried out only for the Portuguese context, preventing the generalization of the results obtained to other realities. Finally, the absence of data in Portugal related to the circularity of the economy, mobility the use of technologies both by citizens and municipalities is another limitation of the study, namely the inclusion of other SC components, namely the use of the Smart Mobility dimension.

These limitations suggest avenues for future research. A first suggestion would be to replicate this study in other geographical contexts, or other units of analysis and do a comparative study. Conducting case studies in Portuguese towns and cities would also be beneficial, for example, case studies of rural and urban villages. Furthermore, this study suggests conducting another future study

in Portuguese cities based on obtaining primary data on the adoption of the circular economy and the use of technologies for citizen engagement as an enabler of entrepreneurship.

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